ABSTRACT

This document describes and quantitatively evaluates the effects of various factors on the detection sensitivity of commercially available portable field instruments being used to conduct radiological surveys in support of decommissioning. The U.S. Nuclear Regulatory Commission (NRC) has amended its regulations to establish residual radioactivity criteria for decommissioning of licensed nuclear facilities. In support of that rulemaking, the Commission has prepared a Generic Environmental Impact Statement (GEIS), consistent with the National Environmental Policy Act (NEPA). The effects of this new rulemaking on the overall cost of decommissioning are among the many factors considered in the GEIS. The overall cost includes the costs of decontamination, waste disposal, and radiological surveys to demonstrate compliance with the applicable guidelines. An important factor affecting the costs of such radiological surveys is the minimum detectable concentration (MDC) of field survey instruments in relation to the residual radioactivity criteria. The purpose of this study was two-fold. First, the data were used to determine the validity of the theoretical minimum detectable concentrations (MDCs) used in the GEIS. Second, the results of the study, published herein, provide guidance to licensees for (a) selection and proper use of portable survey instruments and (b) understanding the field conditions and the extent to which the capabilities of those instruments can be limited. The types of instruments commonly used in field radiological surveys that were evaluated included, in part, gas proportional, Geiger-Mueller (GM), zinc sulfide (ZnS), and sodium iodide (NaI) detectors.

CONTENTS

Section Page

TABLES

FIGURES

ABBREVIATIONS

ANL	Argonne National Laboratory
ANSI	American National Standards Institute, Inc.
BNL	Brookhaven National Laboratory
DCGL	derived concentration guideline level
dpm	disintegrations per minute
EML	Environmental Measurements Laboratory (U.S. Dept. of Energy)
EPA	Environmental Protection Agency
ESSAP	Environmental Survey and Site Assessment Program
FIDLER	Field Instrument for the Detection of Low Energy Radiation
GEIS	Generic Environmental Impact Statement
GM	Geiger-Mueller
LARADS	laser assisted ranging and data system
MDC	minimum detectable concentration
MDCR	minimum detectable count rate
NaI	sodium iodide
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
PNNL	Pacific Northwest National Laboratory
PIC	pressurized ionization chamber
ROC	relative operating characteristic
TEDE	total effective dose equivalent
USRADS	ultrasonic ranging and data system
ZnS	zinc sulfide

ACKNOWLEDGMENTS

This report was a collaborative effort by the staff of the Environmental Survey and Site Assessment Program (ESSAP) of the Oak Ridge Institute for Science and Education, Brookhaven National Laboratory, and the Nuclear Regulatory Commission. In addition to writing certain sections, Eric Abelquist, working closely with Tony Huffert and George Powers of the NRC, was responsible for the overall planning and management of this project. Dr. William Brown, Brookhaven National Laboratory, provided input on the human factors associated with scanning and wrote the bulk of Section 6. Many of the detection sensitivity experiments conducted in this report were designed and performed by Elmer Bjelland and Lea Mashburn, while Jim Payne and Scott Potter performed many measurements during development of the feasibility study. Other technical contributors included Wade Adams, Armin Ansari, William L. (Jack) Beck, Dale Condra, Ray Morton, Ann Payne, Steven King, Tim Vitkus, and Duane Quayle. Elaine Waters, Robyn Ellis, Debi Herrera, Tabatha Fox, and Debbie Adams provided much of the word processing support, while Teresa Bright and Dean Herrera produced all of the graphics.

Special thanks to Jim Berger, George Chabot, Bobby Coleman, Ken Swinth, and Ed Walker who performed valuable reviews of the report and provided thoughtful comments, and to all the computer simulation and field survey test participants.

FOREWORD

The NRC has amended its regulations to establish residual radioactivity criteria for decommissioning of licensed nuclear facilities. In support of that rulemaking, the Commission has prepared a Generic Environmental Impact Statement (GEIS), consistent with the National Environmental Policy Act (NEPA). The effects of this new rulemaking on the overall cost of decommissioning are among the many factors considered in the GElS. The overall cost includes the costs of decontamination, waste disposal, and radiological surveys to demonstrate compliance with the applicable guidelines.

An important factor affecting the costs of such radiological surveys is the minimum detectable concentration (MDC) of field survey instruments in relation to the residual contamination guidelines. This study provides guidance to licensees for (a) selection and proper use of portable survey instruments and (b) understanding the field conditions and the extent to which the capabilities of those instruments can be limited. The types of instruments commonly used in field radiological surveys that were evaluated include, in part, gas proportional, Geiger-Mueller (GM), zinc sulfide (ZnS), and sodium iodide (NaI) detectors. This report describes and quantitatively evaluates the effects of various factors on the detection sensitivity of commercially available portable field instruments being used to conduct radiological surveys in support of decommissioning.

The initial draft of this report was published in August 1995. In response to the comments received, substantial revisions were made to include modifications to the scan MDC approach and the determination of instrument sensitivity for uranium and thorium decay series. The results, approaches and methods described herein are provided for information only.

Cheryl A. Trottier, Chief
Radiation Protection and
Health Effects Branch
Division of Regulatory Applications
Office of Nuclear Regulatory Research